

Sept. 17, 1963

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3,103,875

ROLL DEFLECTION

Filed March 8, 1961

F2G-1

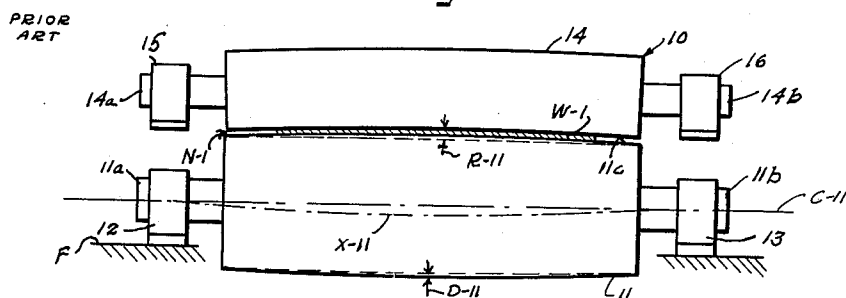


Fig. 2

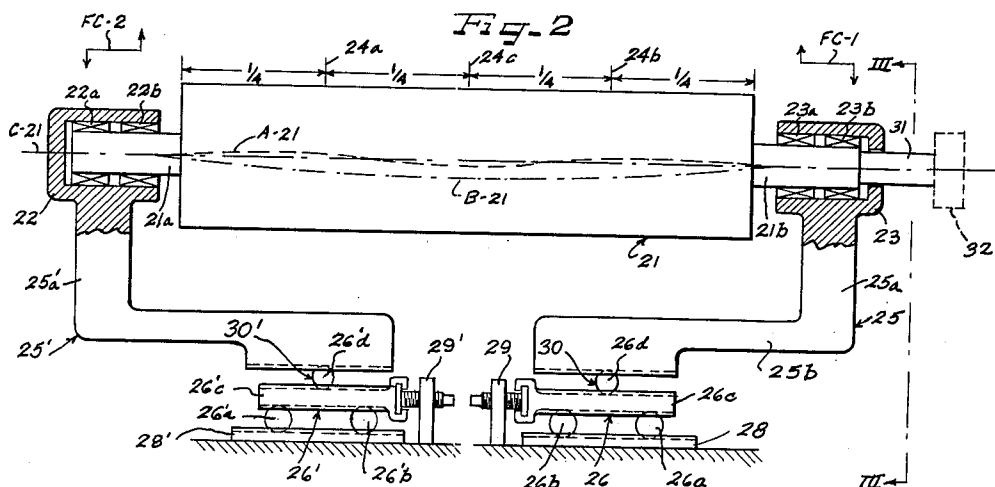
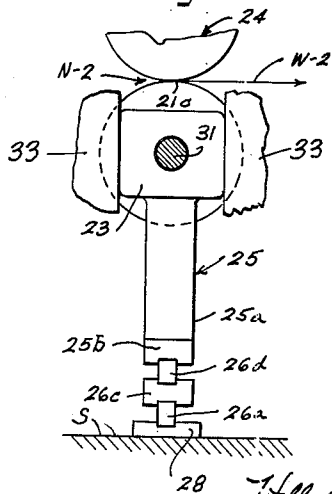


Fig. 3



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ROLL DEFLECTION

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Filed Mar. 8, 1961, Ser. No. 94,261
8 Claims. (Cl. 100—155)

This invention relates to apparatus for mounting a roll whose axis is subject to deflection, and more particularly, to an apparatus for mounting a roll that is subjected to a load tending to effect central deflection of the roll axis.

Although the instant invention may be useful in a number of arts, it is particularly useful in the paper making art and will be described primarily in connection therewith. In paper machines, there are a number of different types of rolls of substantial size (i.e., substantial length-to-diameter ratios) which are subjected to loads tending to deflect such rolls centrally. For example, wire return rolls in a Fourdrinier paper machine are subject to a load tending to effect central deflection thereof by virtue of the weight of the rolls themselves and of the Fourdrinier wire carried by the rolls, the tension on the Fourdrinier wire, and, in the case of a driven roll, the force component resulting from the resistance or reaction of the wire itself to the driving force. These forces tend to deflect the roll downwardly in the middle and this results in an undesirable guidance of the traveling wire, which it has been found advantageous to avoid by counteracting the tendency for downward deflection of the return roll in one manner or another.

In addition, in press couples, calender stacks, etc. the web passes through a nip between a pair of superimposed rolls whereat the web is subjected to pressures. The pressures thus applied at such nip tend to load the lower roll and deflect the same centrally downwardly. Such deflection results in an undesirable application of forces across the nip and other undesirable operating features; and such deflection is often corrected in paper machines by "crowning" of the lower roll. The crowning of the roll requires accurate and expensive finishing of the roll surface so as to obtain a slightly greater roll diameter in the central portion of the roll; but such crowning is carried out on the basis of a predetermined set of force conditions and may not be satisfactory for operation under a different set of force conditions. Accordingly, crowning of rolls often does not afford satisfactory operation for many different types of operating conditions.

In other arts relating to paper machines, such as the coating of paper or fabrics with plastic materials, pressure or calender rolls are also used. Also, paint mixing roll systems or the like are subject to the buildup of forces in the central portion of pressure nips which tend to cause central deflection of the rolls and result in non-uniform and/or other undesirable conditions across the width of such press nips.

The instant invention affords a simple but unique mounting arrangement for a roll subject to a load tending to cause deflection of its axis. One aspect of the instant invention involves the use of force couples applied through allochiral pairs of bearings mounting a roll, i.e., a "right hand" pair and a "left hand" pair of bearings rotatably receiving stub shaft elements at opposite ends of the roll (or looking in the machine direction, at opposite sides of the roll). These pairs of bearings are referred to herein as "allochiral" for the reason that they are opposed right and left hand assemblies although not entirely symmetrical in every detail. The use of a pair of bearings to rotatably receive a shaft at one end of a roll for the purpose of applying a force couple thereto, wherein one of the bearings is fixed and the other movable, is shown

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in the prior art, for example, in Goulding U.S. Patent No. 2,611,150.

In the instant invention, however, both of each pair of bearings in the assembly used to apply a given force couple to the shaft are bearings fixed with respect to each other but carried in a housing that is movable (as contrasted to rigid assembly of one of the bearings in, for example, a stationary frame). Each of the allochiral pairs of bearings, and the housing therefor, is in rigid connection with a lever arm extending therefrom and beneath the roll. These allochiral lever arms carry the entire weight of the roll, bearings and bearing housings, and such lever arms are in turn supported from beneath by means positioned inwardly from the roll ends. This force arrangement thus results in the application of force couples to the shaft elements tending to bow or deflect the roll upwardly. The exact contour which the axis of the roll will take depends, of course, upon the relative strength of the roll and the load applied thereto; but in accordance with the instant invention it also depends upon and may be varied by adjustable positioning of the means supporting the lever arms.

It is, therefore, an important object of the instant invention to provide an improved assembly for mounting a roll subject to a load.

It is another object of the instant invention to provide an improved roll assembly wherein force couples are applied via shaft elements at the ends of a roll subject to a load in a predetermined manner based upon the location of certain adjustably positioned means carrying the weight of the roll.

Yet another object of the instant invention is to provide, in a mounting for a roll whose centroidal axis is subject to deflection (said roll having shaft elements at opposite ends thereof), in combination, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto (for deflecting the axis), allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, and means positioned inwardly from the roll ends supporting the lever arms and the roll carried thereby.

Other and further objects, features and advantages of the instant invention will become apparent to those skilled in the art from the following detailed disclosure thereof and the drawings attached hereto and made a part hereof.

On the drawings:

FIGURE 1 is a diagrammatic illustration showing the two lower rolls of a stack of rolls, illustrating in exaggerated form the manner in which such rolls may be deflected during a specific correlation among the essential control factors in a calender stack of the prior art;

FIGURE 2 is a diagrammatic illustration similar to FIGURE 1, but showing mounting means of the invention for a roll subjected to a load tending to cause deflection; and

FIGURE 3 is an end elevational view taken substantially from the right hand side of FIGURE 2.

As shown on the drawings:

In FIGURE 1, a bottom portion of a calender stack, indicated generally by the reference numeral 10, is shown comprising a king roll 11 at the bottom mounted on suitable bearings 12 and 13 which are in turn firmly secured to a fixed mounting such as a floor F. Immediately above the king roll 11 is a calender roll 14 which, in turn, is mounted for rotation in bearings 15 and 16. Actually, the roll 11 is provided with a left hand stub shaft 11a or shaft element which is rotatably received by the left hand bearing 12 and a right hand stub shaft 11b which is rotatably received by the right hand bearing 13. The roll 14 is also provided with a left hand stub shaft 14a rotatably received by the left hand bearing 15

and a right hand stub shaft 14b rotatably received by the right hand bearing 16.

As will be noted, the axis X-11 for the roll 11 is deflected downwardly below a horizontal or center line C-11 at the middle of the roll 11 and this is caused by the load applied to the roll 11 by the weight of the roll 14 (and any other rolls thereabove). This weight is transmitted through the sheet of paper (shown in exaggerated thickness at W-1) passing through the nip between the rolls 11 and 14. In the calender 10, however, the central portion of the top surface of the roll 11 is still crowned so as to extend a distance R-11 above the outer extremities of the roll 11, and the bottom surface of the roll 11 is downwardly bowed still a greater distance D-11. The amount of operating crown R-11 depends upon the amount of original crown formed on the roll 11 and the total weight of the calender stack of rolls 14, etc. mounted thereabove. As will be appreciated, if it is desired to operate a calender with substantially no operating crown (R-11) in the king roll 11, the initial crown of the king roll 11 and the total weight of the calender rolls 14, etc. are correlated so as to obtain substantially no operating crown. If, however, it then becomes desirable to make a change in the operation of the prior art calender by using less calender rolls in the stack, then a greater operating crown R-11 will be obtained. This may possibly result in an undesirable pressure distribution at the portion of the web W-1 passing through the nip N-1. The same is true with respect to variations in load which may be applied to any other crowned roll in a paper machine or other device.

In many of such prior art devices, the crown initially formed on the roll being subjected to the load is just sufficient to permit the roll to deflect in response to this predetermined load to such an extent that the roll presents a substantially flat (usually horizontal) nip defining surface. It will be appreciated that any variation from such predetermined load will, however, necessarily result in a deviation from the desired flat or level contour of the operating surface or nip defining line of the roll (herein designated 11c).

Referring now to FIGURE 2, it will be seen that the apparatus of the instant invention is adapted to mount a roll 21 whose centroidal axis in the unloaded condition of roll (C-21) is subject to deflection. It will be appreciated that the deflections and crowns indicated in FIGURES 1 and 2 are greatly exaggerated for purposes of simplifying the disclosure.) As indicated diagrammatically in FIGURE 2, the axis C-21 is a center line for the roll 21 which would be a substantially straight, horizontal line in the view of FIGURE 2, if the roll 21 were not subjected to any loading forces including the load of its own weight. The roll 21 is, however, subjected to a load across its entire width, including the load of its weight and the load applied by an upper roll (shown partially at 24 in FIGURE 3 and represented in FIGURE 2 diagrammatically by arrows 24a and 24b at the quarter points and 24c at the center of the roll 21, although such load 24a, b, c is actually applied uniformly across the entire width of the roll 21). As indicated in FIGURE 3, a paper web W-2 traveling along the surface of the upper roll 24 (shown fragmentarily) passes downwardly and into a nip N-2 between the rolls 21 and 24 and then outwardly from the nip N-2.

As shown in FIGURE 2, the roll 21 has shaft elements or stub shafts 21a and 21b at opposite ends thereof. Allochiral pairs of bearings (shown diagrammatically as axially spaced bearings 22a, b as the left hand pair and 23a, b as the right hand pair) rotatably receive the stub shafts 21a and 21b respectively. The right hand pair of bearings 23a, 23b rotatably receive the stub shafts 21a and 21b respectively. The right hand pair of bearings 23a, 23b rotatably receives the stub shaft 21b, with the bearings 23a and 23b spaced each other so that they are adapted to apply a force couple in a

generally vertical plane of the roll axis C-21 and the load 24a, b, c (such couple being represented diagrammatically above the bearings 23a, 23b at FC-1). The bearings 23a and 23b are securely mounted in a conventional housing 23, so that the bearings 23a and 23b will maintain a predetermined spaced relationship (sufficiently close to the retained conveniently in a single housing 23). The bearings 22a and 22b are, likewise, mounted in a housing 22. A lever arm 25 that is rigidly connected to the housing 23 (which in turn is rigidly connected to the bearings 23a, 23b) extends from the housing 23 and bearings 23a, 23b downwardly at 25a and then inwardly from the right hand end of the roll 21 and beneath the roll 21, at 25b. The portion 25b of the lever arm 25 extending beneath the roll 21 is mounted on a suitable carriage 26, which is here shown mounted on track means 28 aligned generally parallel with the center axis C-21 of the roll 21. The carriage 26 preferably comprises a means for readily adjusting the position of the load, e.g., a roll pyramid system consisting of a plurality of spaced lower rollers 26a, 26b on the track 28 carrying a plate 26c which in turn mounts one or more top rollers 26d directly supporting the total load via the arm 25b. Conventional adjustable positioning means (such as a jack screw device or the like indicated diagrammatically at 29) move the carriage 26 to the exact location desired on the track 28. The track means 28 are secured to a rigid support S. As is apparent from FIGURE 2, the left hand pair of bearings 22a, 22b are mounted in a substantially symmetrical assembly wherein parts corresponding to the right hand mounting assembly are designed by the prime of the same reference numeral.

It will be noted that the entire weight of the roll 21, plus the load (24a, 24b, 24c) applied thereto is carried by the allochiral pairs of bearings 22a, b and 23a, b, which are in turn carried by the allochiral lever arms 25, 25' rigidly secured to the pairs of bearings. The load thus transferred to the lever arms 25, 25' is in turn carried by the carriage means 26, 26'. As indicated, the carriage means 26, 26' are effectively positioned at 30, 30' approximately beneath the quarter points (designated respectively at 24b and 24a in FIGURE 2) of the roll 21. This results in a "substantial straightening out" of the roll 21 so as to obtain an axial alignment A-21 shown in dashed lines to deviate from the center line C-21 in greatly exaggerated manner. In the absence of this straightening out effect of the invention, the axis of the roll 21 would deflect centrally under the load 24 along a dot-dash line B-21 also shown to deviate from the center line C-21 in greatly exaggerated manner.

In actual practice, these deviations from the center line C-21 are very small "numerically" but their effects are significant. The center line A-21 is really substantially "straight," so as to present for loading a substantially horizontal straight top surface 21c for the roll 21. The application of the force couple FC-1 at the right hand side will tend to deflect the center line A-21 slightly upwardly at the right hand quarter point 24b; and the opposite couple FC-2 tends to deflect the center line A-21 slightly upwardly at the left hand quarter point 24a. The unsupported center of the roll 21 will respond to the load 24 much like a normal beam and will deflect centrally downwardly slightly (at 24c). This configuration A-21 is, however, substantially "straight" for practical purposes (and much more "straight" than the normal beam deflection line B-21); and it involves a minimum "average" deviation from the theoretical center line C-21.

As indicated in FIGURE 2, the effective support point 30 for the carriage 26 is midway between the wheels 26a, 26b and substantially opposite the quarter point 24b. In most instances, this is preferable for obtaining a minimum average deviation from the theoretical center line C-21 by having a "peak" upward deflection in the

actual center line A—21 at approximately the quarter point 24b. But the invention provides the additional advantage of extremely fine control by adjusting means 29. The carriage 26 is movable preferably in a region inwardly from the roll end or shaft 21b but outwardly from the roll center (at 24c), approximately in the region of the quarter point 24b (which might be expressed numerically as within the region of 10% of the roll length on either side of the quarter point, i.e., 15% to 35% of such roll length inwardly from each end).

An additional advantage of the invention resides in the fact that the force couple FC-1 does not involve the application of an "end" or axially aligned load to the bearings 23a, b; which allows for changes in the overall length of the roll 21 due to operating temperature changes, and which minimizes bearing wear.

In addition, it will be noted that the roll 21 is preferably a driven roll (although not necessarily). For this purpose a drive tang 31 is connected in conventional manner to the stub shaft 21b and extends out of the housing 23 to engage suitable drive means indicated diagrammatically at 32.

As indicated fragmentarily in FIGURE 3, vertical stabilizing means 33, 33 are preferably provided for the housing 23, in the form of tracks slidably receiving the housing 23 and permitting vertical movement.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim as my invention:

1. In a mounting for a roll having a substantial length-to-diameter ratio whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, in combination, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, and means positioned appreciably inwardly from the roll ends supporting the full weight of the lever arms and of the roll carried thereby.

2. In a mounting for a roll whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, in combination, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, said arms supporting the weight of the roll and said bearings, and means positioned inwardly from the roll ends supporting the lever arms from beneath and applying such force couple to said shaft elements.

3. In a mounting for a roll whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, in combination, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, said arms supporting the weight of the roll and said bearings, and means positioned inwardly from the roll ends, supporting the lever arms from beneath and applying such force couple to said shaft elements, said means being independently shiftable generally parallel to the axis of the roll.

4. In a mounting for a roll whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, in combination, allochiral pairs of bearings

rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, track means aligned generally parallel to the roll axis, and carrier means movable in said track means, said carrier means being positioned inwardly from the roll ends, supporting the lever arms from beneath and applying such force couple to said shaft elements.

5. In combination, a roll having a substantial length-to-diameter ratio and whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, means applying a load to said roll tending to effect deflection of the roll axis, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, and means positioned appreciably inwardly from the roll ends supporting the weight of the lever arms and of the roll carried thereby.

6. In combination, a roll whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, means applying a load to said roll tending to effect deflection of the roll axis, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, track means aligned generally parallel to the roll axis, and carrier means movable in said track means, said carrier means being positioned inwardly from the roll ends, supporting the lever arms from beneath and applying such force couple to said shaft elements.

7. In combination, a roll whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, means applying a load to said roll tending to effect deflection of the roll axis, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral lever arms rigid with each of said pairs of bearings and extending therefrom beneath the roll and toward the other of said pairs of bearings, and means positioned inwardly from the roll ends supporting the lever arms from beneath and applying such force couple to said shaft elements.

8. In a mounting for a roll having a substantial length-to-diameter ratio and whose axis is subject to deflection, said roll having shaft elements at opposite ends thereof, in combination, allochiral pairs of bearings rotatably receiving said shaft elements and adapted to apply a force couple thereto, allochiral housing elements rigid with each of said pairs of bearings and maintaining a spaced relation between the bearings of each pair, allochiral lever arms rigid with each of said housing elements and the pair of bearings maintained in spaced relation thereby and extending downwardly from said housing elements beneath the roll and toward the other of said pairs of bearings generally in a vertical plane passing through the centroidal axis of the roll, and means positioned approximately 15% to 35% of the roll length inwardly from the roll ends supporting the weight of the lever arms and of the roll carried thereby.

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